KINETICS OF CHILDHOOD LEAD: THE OMAHA DUPLICATE DIET STUDY. <u>C R</u>
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ABSTRACT

The goal was to calculate the kinetics of childhood blood lead (PbB) from longitudinal studies
and to relate this to experimental data. 21 children 2-3 y.o. living in pre-1955 housing in urban
Omaha, a city with low water and air lead but high residual soil lead, provided "field clean"
PbB q 3 mo x 4; clean catch spot UA for lead (PbU) and creatinine to estimate PbU/d q mo x
12; duplicate diets for food and water lead (PbF) q mo x 12 and handwipe lead (PbHW; 2
wipes, both hands) q mo x 12. Assays of all samples and blanks were done by TI/MS in an
ultraclean laboratory. Results (X $\pm$ SE): PbB 6.4 $\pm$ .3 μg/dL; PbU 2.5 $\pm$ .1 μg/d, PbF 4.9
$\pm$ 1.0 μg/d; PbHW 5.6 $\pm$ 0.3 μg; Renal CL Pb 64.6 $\pm$ 6.1 mL/m^2/d; circulating PbB (PbB
x 8% body wt) 57.7 $\pm$ 3.3 μg; estimated fecal (PbFe) + PbU = 1.5 (PbU) = 3.7 $\pm$ .2 μg/d;
mean residence time (mrt) 20.2 $\pm$ 1.1 d; t ½ 14 $\pm$ .8 d, (cf A.C. Chamberlain et al. 1978: mrt
23 d; t ½ 14 d). Assuming PbU + PbFe + Pb to bone is 2 (PbU), 2 (2.5 μg/d) = 5.0 μg/d
absorbed. If absorbed Pb is 35% of ingested Pb, Pb intake $\cong$ 15 μg/d $\cong$ 5 μg PbF + 10 μg
Pb non-food. PbHW x 2 or 100 mg soil with only 100 ppm Pb will account for 10 μg non-food
Pb. Despite the short t ½ of 14 d, modest increases in non-food Pb will rapidly increase PbB.
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SUBJECTS

	Black	Non Black	Total
Male	3	6	9
Female	5	7	12
Total	8	13	21

Age 2.2 $\pm$ 0.4 y
PbB 6.4 $\pm$ 0.3 (2.0 - 16.2) μg/dL

Pre-1955 Housing	19
Lead Hazard	1
Lead Pipes	5
Poverty	10
Non Poverty	11

METHODS

Monthly home visit x 12   1990-1992
   Duplicate diet for lead, nutritional analysis
   24 h food diary
   Anthropometrics
   Blood lead (quarterly)
   Handwipe lead
   Urine (clean catch) lead and creatinine
   Dust index
All collections field clean; all handling in filtered air chambers; all lead assays by TI/MS isotope dilution

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Lead Intake, 2-3 y.o., Omaha

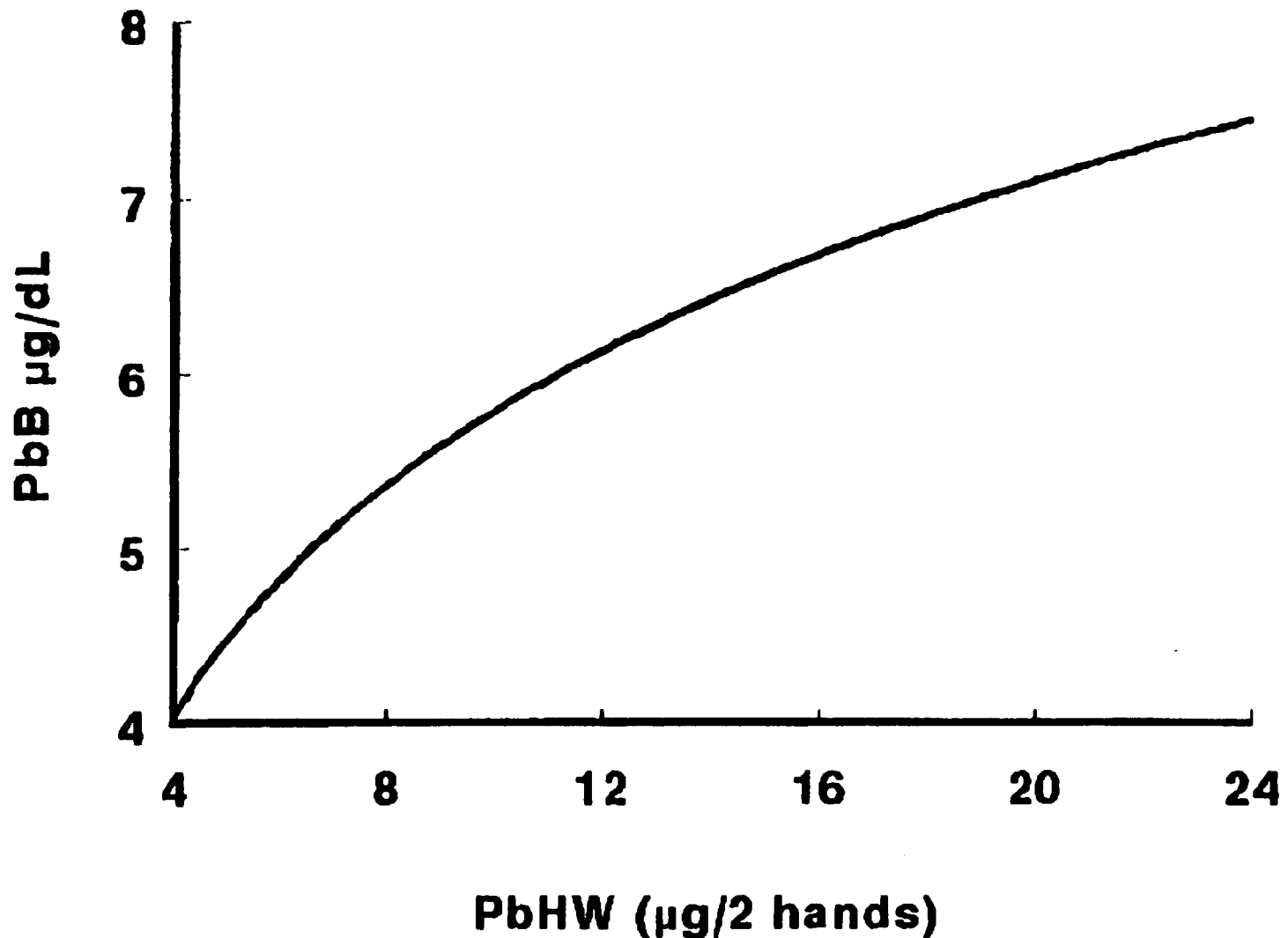|	Gp 1 (15)		Gp 2 (6)
PbB μg/dL			
PbHW μg	< 2		≥ 2
PbB μg/dL	5.6 ± 0.5	*	8.6 ± 1.8
PbU μg/dL[1]	2.5 ± 0.3		2.4 ± 0.5
Pb Absorbed μg/d[2]	5.0		4.8
Pb Ingested μg/d[3]	15		14.4

*p < .05 Gp 1 vs Gp 2

[1]Urine lead μg/d = spot urine lead μg/mg creatinine x 24 h creatinine, predicted by height and age. Viteri FE, Alverado J. The creatinine height index. *Pediatrics* 1970:46:696-706. Predicted PbU μg/d (n = 252) was 1.8 x PbU measured on 11 collections of 10-24 h.
[2]Lead absorbed /d   ≈ PbU + Pb Fecal + Pb Stored
                      ≈ 2.0 (PbU)
[3]Assumes 33% absorption. If 10% absorption of non food lead, total ingested lead ≅ 38 μg/d

Blood Lead Predicted by Handwipe
at Constant Food Lead and Dust Index

PbHW (µg/2 hands)

Food and Non Food Lead

	Gp 1 (15)		Gp 2 (6)
PbB μg/dL	< 2		≥ 2
PbHW μg			
Pb Ingested μg/d	15.0		14.4
-Pb Food μg/d[1]	-6.5 ± 0.6	*	-4.9 ± 0.7
Pb Non Food μg/d	8.5		9.5

Environmental Sources

	Gp 1 (15)		Gp 2 (6)
Pb HW μg[2]	6.5 ± 0.6	*	3.5 ± 1.1
Pb Play Floor μg/m²	62 ± 12		90 + 54
Pb Sill μg/m²	749 ± 163		714 ± 690
Home Index[3]	6.0 ± 0.7		4.8 ± 1.1
Other[4]		ns	

[1] Pb Food/1000 kcal = 6.7 ± 0.7 (Gp 1), 4.6 ± 0.6 (Gp 2) μg/1000 kcal
[2] Handwipe lead = total lead, 2 "wet wipes," all surfaces, both hands
[3] 0 = minimal lead risk; 10 = maximal
[4] No significant differences Gp 1 vs Gp 2 in demographics, stature, nutritional intake, monthly dust index, lead in soil μg/g, air duct μg/g, door mat μg/mat, tap water (peak = 2.2 μg/L). Annual air lead, central monitor, .05 ± .005 μg/m³. At respiratory volume 8 m³/d, intake = 0.4 μg/d.

Kinetics

	Omaha 2-3 y.o.			Chamberlain - Adults[5]
n	15 (Gp 1)		6 (Gp 2)	3-5
PbB μg/dL	5.6	*	8.6	²⁰³Pb
PbU μg/d[1]	2.5		2.4	
Pb circ μg[2]	48.8	*	78.6	
Renal C_{p}, mL/m²/d[3]	71.8	*	43.7	51[6]
T 1/2 days ± SD[4]	12.6 ± 3.7	*	18.2 ± 2.2	15.4 ± 6.0[7]

*p < .01 Gp 1 vs Gp 2

[1] PbU/d = PbU μg/mg Cr x 24 h creatinine predicted by height and age.
[2] PbB circulating = PbB μg/L x (8% body wt, kg).
[3] Renal clearance Pb mL/m²/d = $\frac{PbU\ \mu g/d}{PbB\ \mu g/mL}$ x $\frac{1.0\ m^2}{surface\ area}$

[4] T 1/2 = .693 mean residence time (mrt) mrt = $\frac{PbB\ circulating\ \mu g}{Pb\ excreted/d}$ = $\frac{PbB\ cirulating\ \mu g}{1.5\ (PbU\ \mu g/d)}$

[5] Chamberlain AC, Heard MJ, Little P, et al. Investigations into Lead from Motor Vehicles. United Kingdom Atomic Energy Authority, November 1978.
[6] Ref 5, Table 8.4 and p 92: Renal clearance = 3.82 mL/h/1.8 m² = 92 mL/d/1.8 m² = 51 mL/d/1.0 m²
[7] Ref 5, Table 9.5

ℓn monthly PbB   ss = 15*; n = 82; df = 56

		SE	p	r²
Intercept	.7651	.1469	.0001	.06
	β			
ℓn PbHW	.2792	.0607	.0001	.29
ℓn PbF	.1578	.0730	.03	.08
ℓn DI	.0787	.0200	.0002	.23
			adj r²	.46

*Excludes the 6 children of Gp 2 with $\left(\frac{PbB\ \mu g/dL}{PbHW\ \mu g} \geq 2 \right)$, whose monthly PbHW and PbF did not predict PbB.

CONCLUSIONS

In 21 Children 2-3 y. o., PbB 2-16.2 μg/dL

1. T 1/2 PbB 12-18 d,
   - Similar to Adult T 1/2 ^{203}Pb
   - Increases with PbB

2. Absorbed Lead (est)   5 μg/d

3. Ingested Lead (est)   15 μg/d
   - Food Lead 5 μg/d
   - Non Food Lead 10 μg/d
   - Non Food Lead ≅ 2 x Handwipe Lead

4. PbB Predictors   r²
   - Handwipe Pb   .29
   - Household Dust Index   .26
   - Food Lead   .08
         (adj)   .46